Space Weather Technical Forecast

Issued on Saturday, 09 March 2024 at 01:10 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of G1/Minor Storm in next 24 hours. Daily Chance of M-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with a peak flare of M1.3 at 08/2126 UTC from AR3599. There remain six numbered sunspot regions on the visible disc. The largest and most complex region, AR3599 showed minimal changes, still retaining at least one Mt Wilson delta spot, the most evident one in its leading portion. All other spots are small, stable or showing a gradual decaying trend.

No Earth directed CMEs have been observed in coronagraph imagery, though imagery post M-class flare is still sparse and may present something in coming hours.

Solar Wind / Geomagnetic Activity: Solar wind parameters observed by ACE/DSCOVR at L1 suggested a fast solar wind environment from CH06/-. The solar wind speed rose to elevated from 08/0530 UTC to an eventual peak near 550 km/s at 08/0805 UTC, before gradually falling back to slightly elevated levels with minor increases during second half of 08 March. The density started moderate, falling back to background later. The IMF was weak throughout, peaking early in the period at 7nT, while the north-south component was changeable between +5 and -6nT. Phi angle was negative (toward the Sun) throughout. The net result of the above solar wind measures was for Unsettled (Kp 3) geomagnetic activity initially, which became Quiet thereafter (Kp 0-2), before ending with an Active (Kp 4) interval.

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux was at Background levels.

High energy electron flux (greater than 2MeV) observed at GOES16 was at Normal Background to Moderate levels with a peak at 116pfu at 08/0105 UTC. The associated 24 hour fluence well below the Active (1e8 integrated pfu) threshold. The observed 24-hour fluence at 09/0000 UTC was 1.58e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Expected to remain generally low with a Chance of an isolated M-class flare, mainly from AR3599. No significant regions leave or arrive in the period, meaning the trend is flat.

Solar Wind / Geomagnetic Activity: Up to two CMEs may affect Earth in the forecast period.

Recent solar wind parameters indicate the continued connection to CH06/-. Solar winds may be further enhanced by the arrival of a CME early in the period. This is expected to be a glancing blow from a CME which left the Sun on 05 March. Another glancing CME is possible on 11 March from a CME which left the Sun on 07 March, though this is low confidence.

Unsettled activity in the fast wind may give way to a Chance of G1/Minor Storm in the next 12 hours (first half of day 1) due to the glancing CME from 05 March. Geomagnetic activity should

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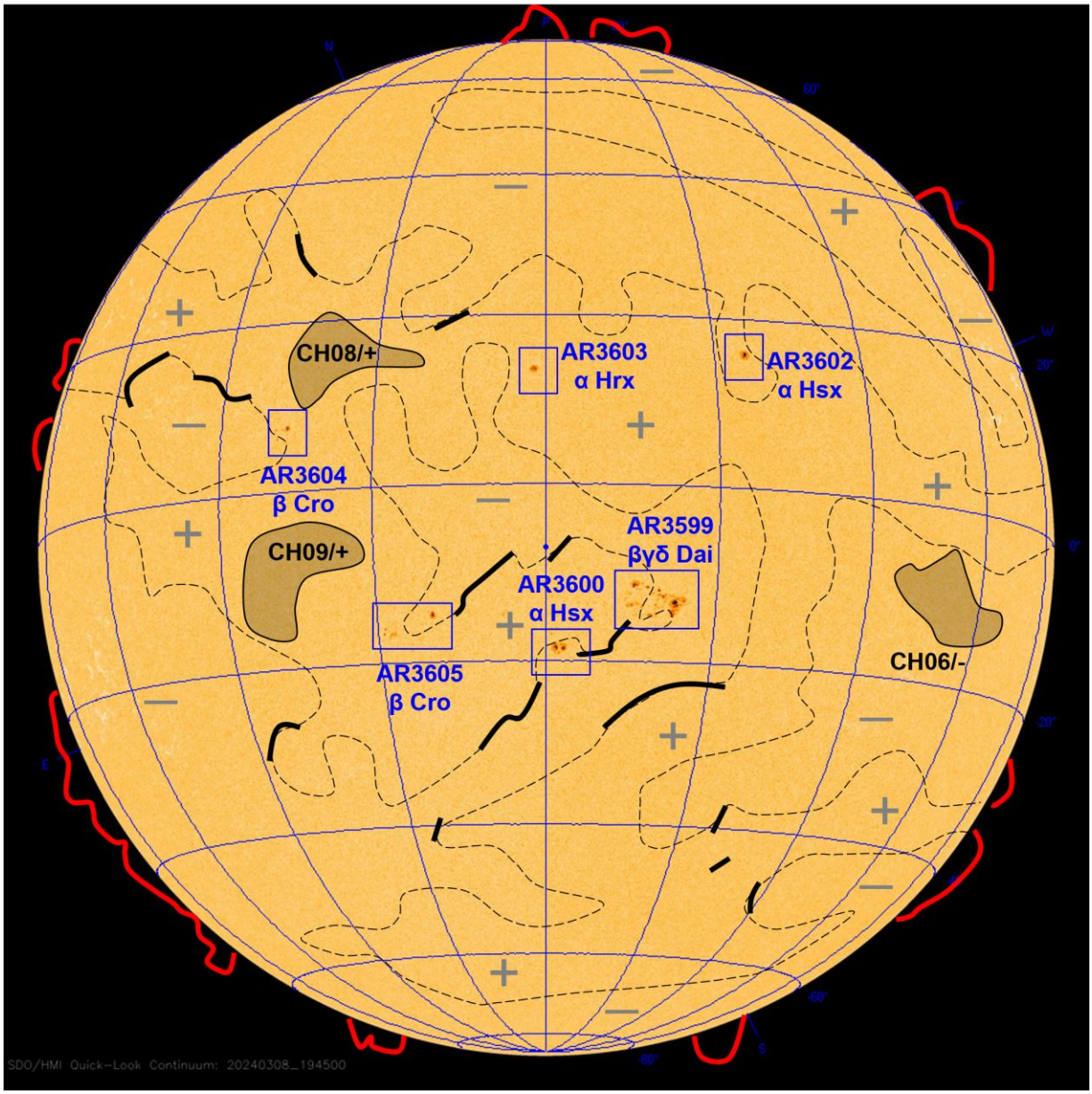
then become Quiet from day 2 (10 March) as the fast wind similarly eases, perhaps with a Slight Chance of G1/Minor Storm intervals day 3 (11 March) should the 07 March CME affect Earth.

Energetic Particles / Solar Radiation: GOES18 high energy proton flux is expected to persist at Background levels. GOES16 high energy electron flux is expected to remain at mainly Background levels, perhaps reaching more consistent Moderate levels after the CH HSS subsides. The associated 24-hour fluence is expected to remain below the Active threshold, with a daily Slight Chance of rising above Active from 10 March onward.

Figure 1. Solar Analysis Valid 08/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The forecast now comprises the fast wind regime from CH06/- and up to two CMEs: from 05 and 07 March.

The fast wind currently being sampled by Earth is considered most likely to be that stemming from CH06/-, and recent solar wind speeds are indicating the peak speeds may have already been achieved, speeds should gradually fall, bar any CME enhancement, over coming days.

The first of the CMEs in the forecast originated from a filament lift off in the southeast on 05 March, and has been assessed as providing a risk of a glancing blow inside the next 12 hours, although the majority of the CME is expected to pass below and behind Earth's orbit.

The second possible glancing CME is from the northwest-central dimming seen around 07/1300UTC. Confidence is notably low surrounding this event, however there is perhaps a Slight Chance of G1 peaking around 11/0600UTC. MOSWOC Enlil modelling is suggesting an erroneous fast wind due around this time which will likely unduly accelerate any nested CMEs and reduce their transit times to Earth - this suggested arrival time does try to account for this.

All considered, initial Unsettled activity in the fast wind may give way to a peak Chance of G1/Minor Storm in the next 12 hours due to the glancing CME from 05 March. Geomagnetic activity should then become Quiet from day 2 (10 March) as the fast wind similarly eases, perhaps with a Slight Chance of G1/Minor Storm intervals day 3 (11 March) should the 07 March CME affect Earth.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	40	10	20	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
06/0210	Partial	Filament Eruption	SE	790 km/s	09/0001UTC	Glancing blow
07/2215	Partial	Dimming, filament	NW central	450 km/s	11/0600UTC	Low confidence, glancing blow

Figure 2: MOSWOC ENLIL

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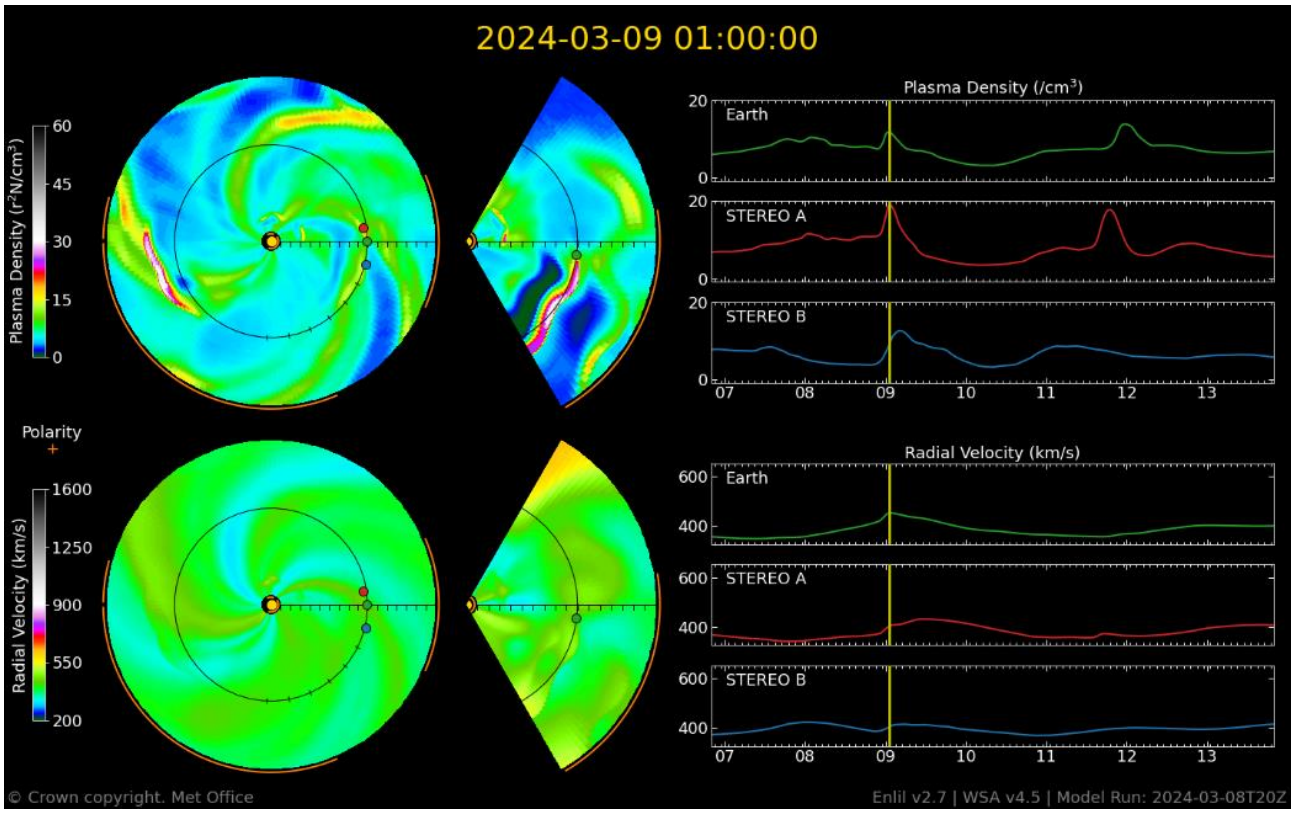

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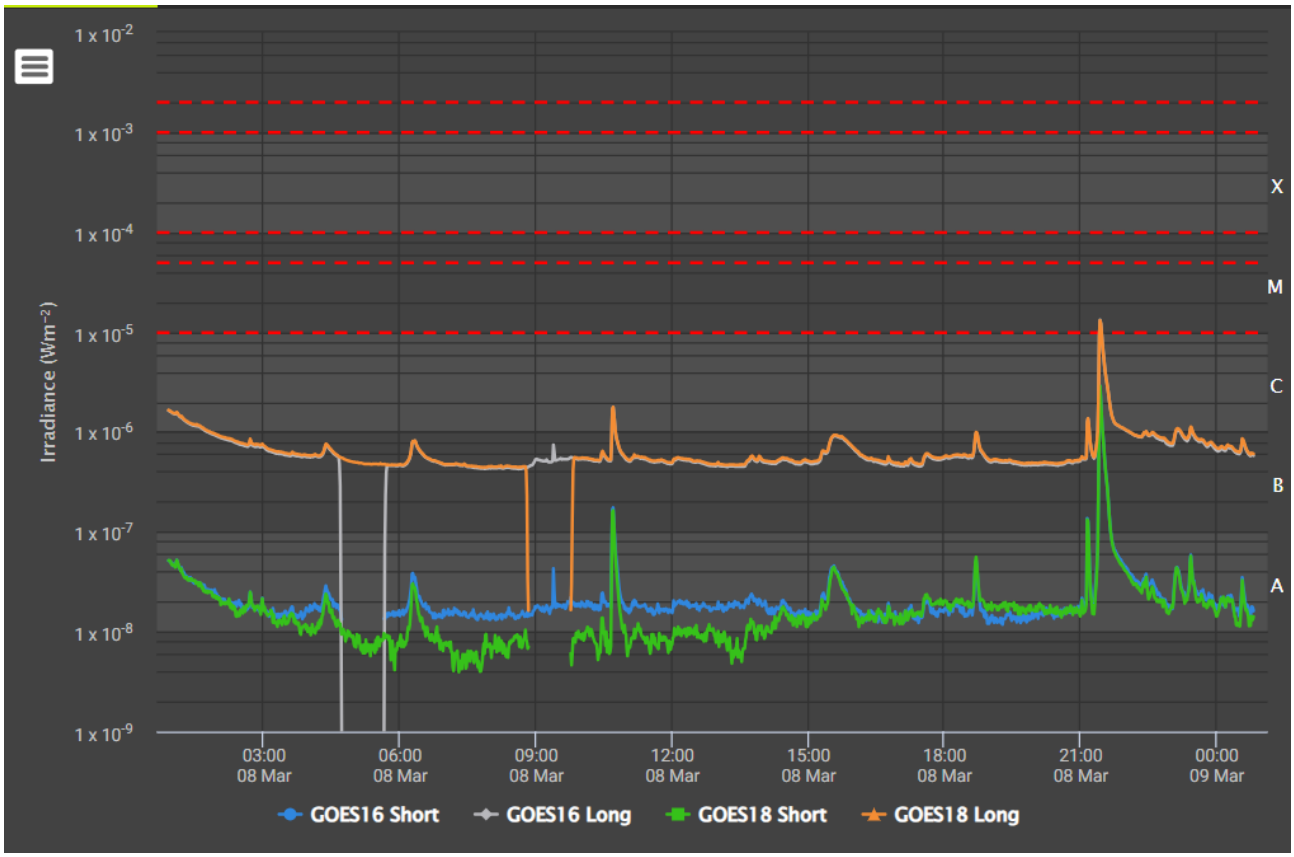
Radio Blackouts - X-Ray Flares:

The current Earth-facing disc is mostly devoid of potent sunspot regions, and the one exception to this, AR3599, has shown some signs of a simplifying trend in the past 24 hours. These have included the fading of at least one of its Mount Wilson delta spot candidates, as well as a reduction in penumbral area.

The fortunes of the disc are largely tied to this one spot group, with a daily Chance for M-class. This sunspot group remains on the visible disc throughout the coming four days, and far-side soundings do not currently suggest any major oncoming regions as due during the period, meaning the overall risk is held constant.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: 24 hour X-ray trace



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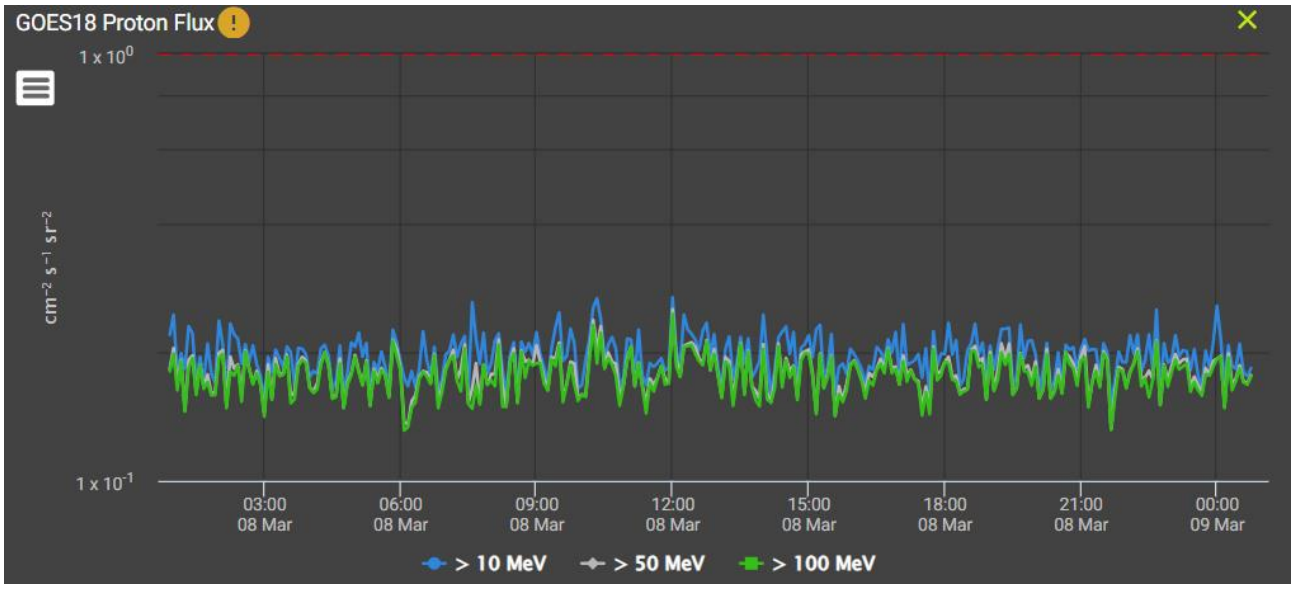
Solar Radiation Storms - (High Energy Protons):

GOES18 proton flux is currently at Background levels. No recent enhancements have been noted anywhere on the disc, including northwest limb activity of the past 24 hours. Despite this, this off-going part of the facing side of the Sun is perhaps responsible for the bulk of any S1+ risk in the first half of the period, later transitioning to AR3599 as it makes its way well onto the western side of the Sun into the coming new UTC week. The net result is a roughly constant Slight Chance of S1+, as the west limb contribution fades as a counterpoint to AR3599's increase.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: 24 hour proton trace (GOES18)



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High Energy Electrons Event (≥ 2MeV):

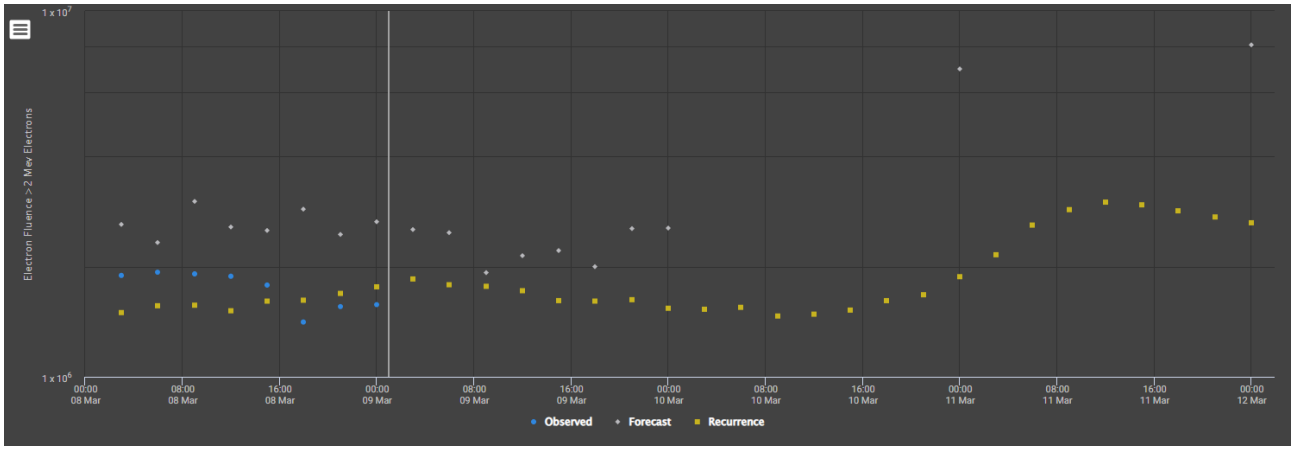
High energy electron flux (greater than 2MeV) has varied between Normal Background and Moderate levels, and is expected to remain so through much of the forecast period. The main drivers for any change to the current steady state are the fast wind regime and then up to two CME arrivals.

The fast wind regime from CH06/- appears to be have peaked between 500-550 km/s. The peak potency of this feature is rendered more difficult to assess as it was not present on last rotation, however the possibility of further slight rises in solar wind speed is the rationale for the very slight increase in risk into the coming UTC weekend. This will be complicated by the possible 05 March CME arrival early in this timeframe, ahead of a further possible redistribution of electrons come Monday 11 March should the 07 March CME arrive. The high speed stream from CH06/- is expected to charge the electron belts, whereas any CME may 'snowplough' these electros away from their orbits.

The presence of up to two transients in the period now renders MOSWOC REFM less useful, however the most likely forecast remains a continuation of the now long-term habit of sub-Active 24-hour integrated electron fluence.

GEO Electron Environment	Level ($cm^{-2}\ sr^{-1}\ day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	5	10	10
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: MOSWOC REFM fluence forecast/observations/recurrance



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